GRADUATE STUDENT SUPPORT FOR STUDIES ON WAVE-SEABED INTERACTIONS

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FINAL TECHNICAL REPORT

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This project supported the graduate studies of two Ph.D. students. The scientific goal, objectives, approach, work completed, results, impact, and a list of publications are given below.

LONG-TERM GOAL

Our long-term goal is to develop a model that will predict local sand transport and bathymetric change due to waves and currents under time-varying conditions.

SCIENTIFIC OBJECTIVES

Accomplishment of the long-term goal will require significant improvement of our understanding of the relationships between hydrodynamics and sediment motion near the seabed, as well as the development of models derived from our understanding of the relevant physical processes. This requires coupling between hydrodynamic forcing, bedform response and feedback, bedload sediment transport response, and the suspended sediment response.

APPROACH

Model development is being pursued in combination with the analysis of observations obtained in the field and in large-scale laboratory facilities. Observations of bedforms, nearbed suspended sediment, and hydrodynamics provide a basis for the discovery of phenomena that will be incorporated into the development of models. We are focusing on the small-scale dynamics of turbulence and suspended sediment in the vicinity of bedforms, the coupling of bedload and suspended load, and a theory for bedload sediment transport based upon granular mechanics.

WORK COMPLETED

We have analyzed the bedform dimensions from the Sandyduck97 and SISTEX99 data sets. The bedform observations from Sandyduck97 have been combined with previous observations and submitted for publication. An improved method of resolving short wave ripples from MTA data has been developed.

Four particular data runs from Sandyduck97 have been analyzed with respect to the distribution of suspended sediment over long wave ripples. The measured bedforms and hydrodynamics have been used as input to drive the Dune2d numerical model of the bottom boundary layer.

Three methods of estimating turbulence from ADV measurements have been applied to the data sets.

Pressure gradient and bed-slope terms have been added to the kinetic bedload model of Jenkins and Hanes (1998).

RESULTS

The vertical distributions of suspended sediment concentration were investigated over low amplitude long wave ripples in four different data sets with comparable hydrodynamic conditions and with the sediment concentration measurements at relatively different cross-shore locations over the bedforms. The bedform and location of the suspended sediment concentration profiles (ABS) are shown in figure 1. The concentration profiles exhibit different temporal patterns that relate to their different locations over the bedforms, as shown in figure 2. In figure 2 the upper panels show the ensemble average of the cross-shore fluid velocity and the ensemble average of the depth integrated suspended sediment concentration. The lower panels show the ensemble average of the vertical distribution of suspended sediment as a function of the wave phase. The vertical and temporal structure of the concentration profiles indicates a phase lead at higher elevations, which is consistent with the horizontal advection of clouds of suspended sediment by the wave induced orbital fluid motion. By assuming the clouds of sediment are advected horizontally by the measured currents, the cloud is found to be located near the ripple trough at the time of flow reversal.

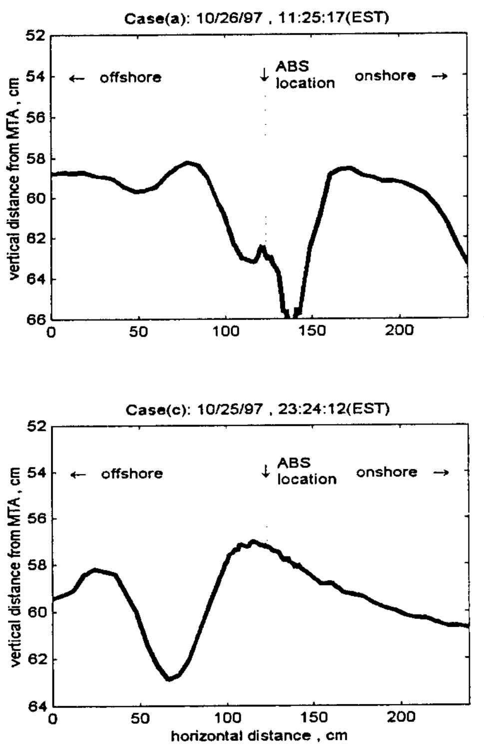

Figure 1: Measured bedforms with location of ABS as indicated.

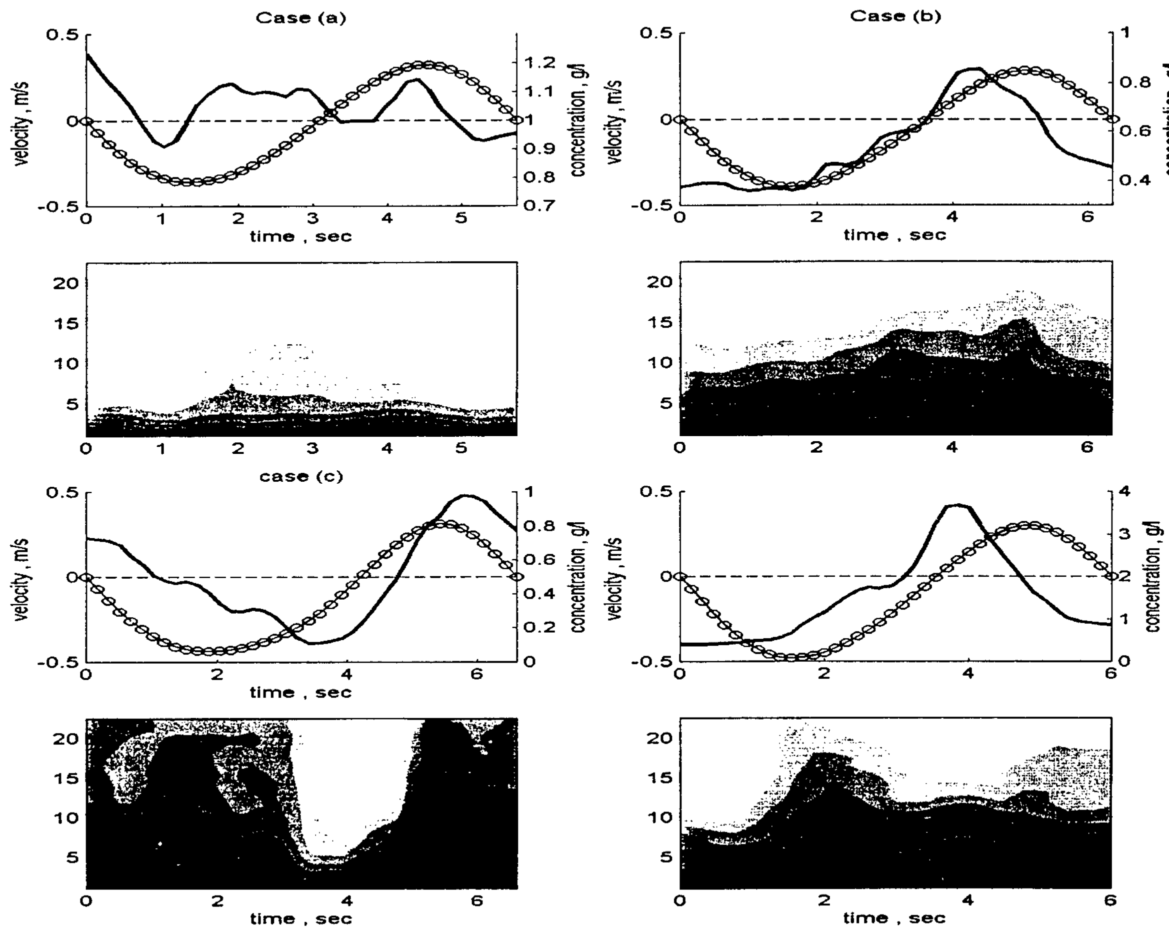

Figure 2: Ensemble averaged cross-shore velocity, vertically integrated suspended load, and vertical distribution of suspended sediment concentration, all as a function of ensemble averaged wave phase. Cases a, b, c, and d correspond to figure 1.

IMPACT/APPLICATION

The connections between small scale and large scale sedimentation processes are important in order to develop a comprehensive understanding of nearshore sedimentation processes, and an ability to model bathymetric change. Our research provides new information on small-scale processes that will allow these connections to be discovered and verified.

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14. ABSTRACT
Two Graduate students were supported to conduct research on small-scale sedimentation processes in the nearshore region. Field observations of bedforms and sediment dynamics indicate that the amount of sediment suspended by waves in shallow water is related to the hydrodynamics, the bedstate, and the intensity of turbulence in the wave boundary layer.

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